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FINANCIAL HEALTH OF U.S. FARM BUSINESSES IN 1984
A Region, Type and Size Analysis

by

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ABSTRACT

Liquidity, solvency, and profitability indicators are used to develop a multi-dimensional ordinal measure of farm business financial health. Weighted ordinal logistic regression is employed to examine farm business financial health relative to region, type and size of farm. Findings suggest the "farm crisis" in 1984 was more severe from a farm business perspective than previously reported.

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INTRODUCTION

The U.S. farm sector has experienced a period of substantive economic decline over the past five years. Farm real estate values, a reflection of farm business economic health, peaked in 1981 and have declined each year since. Farm debt, after a decade of rapid increase, has leveled off and only recently begun to decrease. The increasing number and amount of farm loans being liquidated and/or in a delinquent state during this period evidence the growing degree of financial ill-health on U.S. farms (Wilkinson, October 1985).

Numerous studies have enhanced the understanding of the "farm crisis" from state, regional and national perspectives (USDA, July 1985; Lines and Zulauf; Dobson, et.al.; Lines and Pelly; Food and Agricultural Policy Research Institute [FAPRI]). These studies examined the immediacy of farm family financial stress using debt-to-asset ratios and/or cash balances for indicators. Focusing attention on the near-term cash crisis that farm families have been experiencing, these studies appropriately incorporated cash generating and conservation strategies commonly employed by farm families. This study changes the focus to the intermediate and longer run by stressing profitability of the business.

The objective of this study was to improve understanding of the U.S. "farm crisis" from a business management perspective by: (a) development of a

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comprehensive multi-dimensional indicator of farm business financial health and (b) rigorously analyzing cross-sectional data to determine the statistical association of region, farm type and farm size with relative farm business financial health.

The paper is organized as follows: (a) development of the conceptual framework and the ordinal measure of farm business financial health, (b) a discussion of the data base and estimation methods, (c) the model used to estimate sample parameters is presented, and (d) results are provided, interpreted and summarized.

ORDINAL MEASURE OF FINANCIAL HEALTH

Assessment of financial health, from a business management perspective, includes some measure of: (a) liquidity - the ability of the business to meet its short term financial obligations, (b) solvency - a measure of risk bearing ability and (c) profitability - an indicator of longer-run survivability. Previous studies have not simultaneously considered these measures of financial viability. Long-run farm business financial health has not been captured by using cash balance and/or debt-to-asset ratios for the following reasons: (a) non-farm earnings and unpaid family labor subsidized farm losses, (b) positive cash flows were created by allowing farm families to "live off of depreciation" and (c) unaccounted-for changes in inventory temporarily disguised or created cash flow stress.

A multi-dimensional ordinal variable was developed to incorporate these elements into the assessment of farm business financial health. It was constructed (Table 1) using heuristic rules to establish criterion levels. Liquidity, solvency and profitability, respectively, were assumed satisfactory (+) if: (a) the business could meet its short-run cash needs (operating

costs, operator labor charges, and principal payments), (b) debt-to-asset ratio did not exceed the point where lender and farmer were equally invested (.5) and (c) rate of return to assets was not less than the average long-term current return to farm assets (.04) (Melichar); otherwise they were unsatisfactory (-).

Profitability was the prime determinant of the ordinal ranking of farm business financial health. A favorable profit picture was viewed as most important since it indicates, ceteris paribus, an ability to correct unsatisfactory liquidity and/or solvency. Liquidity was the second criteria for ranking financial health. A business was perceived to be in a better financial state, ceteris paribus, if it did not have to borrow additional funds to meet cash obligations, regardless of profit condition, and thus commit itself to paying current expenses out of future income. Support for liquidity as the second ranking criteria is evident by noticing that an unfavorable solvency position for farms displaying favorable profit and liquidity did not create liquidity problems (that is, profits were great enough to service higher debt-to-asset ratios and yet maintain favorable cash balances).

DATA BASE AND ESTIMATION METHODS

The source of data was the 1984 Farm Costs and Returns Survey (FCRS). The survey, a joint effort of the Statistical Reporting Service and the Economic Research Service, U.S. Department of Agriculture (USDA), consisted of 23,286 personal interviews by 1600 trained enumerators and yielded 13,003 usable questionnaires. The data collected on farm expenditures, income, capital investments, inventories and financial information relative to demographic and other farm characteristics has been used extensively in other financial

analyses of the farm sector (USDA, July 1985; Melichar, October 1985) A multi-frame, stratified sample consisting of list and area frames was surveyed. Farms from the list frame were stratified by various criteria such as economic size and size of labor force; the area frame was stratified by land use type. The sampling scheme allowed for the construction of survey expansion factors which were equal to the inverse of the selection probability. The expanded number of farms covered by the FCRS totalled 1.7 million, compared with 2.2 million farms from the 1982 Census of Agriculture. The Census included .3 million farms with sales of less than $1,000 which were excluded from the FCRS. Most undercounting of farms was for small sales classes. The survey provided a representative count for commercial farms (USDA, July 1985).

Data properties, in particular the ordinal nature of the dependent variable, limited the candidates for estimation technique to models of qualitative choice. Alternative specifications within this class of models include the linear probability model, the linear discriminant model, the probit model, and the logit model.

Empirical applications of the linear probability model have been discouraged based on problems that arise when conventional linear regression principles are imposed on a specification which includes a non-continuous dependent variable (Pindyck and Rubinfeld; Judge, et.al.). The linear discriminant model has received considerable use in analyses of qualitative choice. It has been shown, however, that presence of discrete exogenous variables within the model violates the basic assumption of multivariate normality (Halperin, et. al.; Press and Wilson; Harrell and Lee; Efron). As a

consequence, significance tests regarding coefficients of the linear discriminant model may yield misleading conclusions.

The probit and logit formulations are monotonic transformations which insure that predicted values of the dependent variable are confined to its range. The probit model is based on the standard normal density function, while the logit model relies on the logistic density function. It is often argued that the logit model has computational advantages since it is a closed functional form with convenient curvature properties for numerical optimization. The probit model, on the other hand, has as its argument the limit of an integral which cannot be expressed in closed form. This justification for the choice of the logit model over the probit model is tenuous for binary dependent variable applications, since with maximum likelihood estimation (as occurs in most applications) computational difficulties are virtually undistinguishable regardless of standard distribution function selected (Capps). Applications of both models may be found in recent agricultural economics studies of qualitative choice (Chambers and Foster, probit; Garcia et al., Lines and Zulauf, logit; and Capps and Kramer, logit and probit). Empirically, the choice between probit and logit is based on convenience, especially with respect to available computer software. In this study the logit model was applied since available software easily handled the complexities of estimation given the eight class ordinal variable and the availability of survey weights.

ECONOMETRIC MODEL

LOGIST, a SAS procedure, was used to estimate the probability of a business being in financial health category j or above (Harrel, 1983; Harrel, 1985). Because of the biased nature of the sample, a weighted LOGIST procedure was

used (DuMouchel, et. al.). The weights in this case correspond to the survey expansion factors described above. The weighted ordinal logistic model for this dependent variable having values 0,1,...7, can be stated as follows for $1 \leq j \leq 7$:

$$\text{Probability } (Y_i \geq j) = 1/e^{-(\alpha_j + \beta_1 X_{i1} W_i + \ldots + \beta_n X_{in} W_i)}$$

Parameters were estimated using the following log linear transformation:

$$\text{logit Probability } (Y_i \geq j) = \alpha_j + \beta_1 X_{i1} W_i + \ldots + \beta_n X_{in} W_i)$$

where: Y_i = ordinal indicator for i^{th} observation
j = value of ordinal indicator
α_j = intercept term
X_i = predictors for i^{th} observation
β = regression coefficients
W_i = weight variable for i^{th} observation

A separate parameter α_j is required for each level of $Y_i = 1,2,\ldots 7$ and Probability $(Y_i = 0)$ is obtained from 1-Probability $(Y_i \geq 1)$. The model uses the ordering of Ys, but no assumptions are made regarding the spacing of scale intervals. Other model assumptions include independence of the Xs and linearity in each X (Harrel and Lee). The independent variables include: (a) a dummy variable for each of ten U.S. agricultural regions, as defined by the Statistical Reporting Service, (b) a dummy variable for each of ten farm types, as defined by Standard Industrial Code classifications, (c) a dummy variable for type of business organization (proprietorship or not), (d) a dummy variable for degree of enterprise specialization, (e) log of gross income (a measure of size), and (f) percent of land operated that is rented.

Corn Belt, Lake State and Northern Plains farms and cash grain, livestock, and dairy farms were hypothesized to have a higher probability of being in worse financial health (USDA, 1985): cash grain because of declining crop prices and increasing land debt, livestock and dairy because of their high

ratio of depreciable assets to total assets. Large farms were expected to be in better financial health than smaller farms (USDA, 1985), as were businesses that rented a higher proportion of the operated acreage (Lines and Zulauf). Specialized farms and proprietorships were anticipated to be in better financial health because of the ability to spread overhead costs and the potential for closer cost control and better management, respectively.

RESULTS

The relative incidence of financial health categories with respect to farm size, type and region are provided in Tables 2 - 4. The distributions have a bi-modal character. Farm businesses, for the most part, exhibited either good or poor financial health. The reader is reminded that this analysis excludes off-farm earnings, but includes estimated inventory changes, depreciation allowances, and charges for family labor.

The financial health of commercial farms was better than for all farms and that of larger commercial farms was better than smaller commercial farms (Table 2). Restricting the analysis to commercial farms (at least $40,000 gross income) changed the distribution of financial health, relative to all farms. Nearly seventy percent of all farms had poor financial health (categories 6 and 7); only forty percent of commercial farms were so classified; approximately forty percent of commercial farms and only twenty percent of all farms were in good financial health (categories 0 and 1). Restricting size to a minimum of $100,000 and then $250,000 further shifted the distribution away from poor financial health categories toward good. Approximately fifty-five percent of the largest commercial farms (at least $250,000 gross income) were in good financial health; one-fourth remained in

poor condition. These results suggest a strong continuum of improved financial health associated with farm size.

Tables 3 and 4 clearly demonstrate (a) regional and farm type differences in farm business financial health and (b) commercial farms had better financial health, irrespective of region or type of farm. On an "all farms" basis, farm business financial health worsened as the region changed from Northern Plains to Corn Belt to Northeast. This result is probably due to the larger relative number of farms with sales less than $40,000 occurring in the Northeast. In particular, farms with sales less than $40,000 that without off-farm income appear to be in poor business financial health. When restricted to commercial farms, there was little apparent difference between Corn Belt and Northern Plains farms; but Northeast farms remained in worse financial condition. In 1984, commercial farms had better financial health than "all farms", regardless of the region. On an "all farms" basis, livestock and nursery/greenhouse farms were in poorer financial health than grain farms. When only commercial farms were considered, nursery/greenhouse farms were in better financial health than either grain or livestock farms; and livestock farms remained in the worst financial condition. Regardless of type, commercial farms exhibited better financial health than did "all farms".

The estimated changes in probability and beta coefficients in Table 5 must be interpreted with care. The ordinal character and definition of the dependent variable (odds of being classified in category j or higher) require variable specification as the point of reference for expressing changes in probability. In Table 5 this is the probability of being in category 6 or greater. The nature of the independent variable (continuous vs. binary) also influences the interpretation of the change in probability. For continuous

variables, the usual elasticity interpretation holds. For binary variables, however, the change in probability is relative to the omitted category. The changes in probability are interpreted as follows: (a) A commercial farm in the Northeast (a binary variable) had a 10 percent greater chance of being in category 6 or greater (reference point) than did a commercial farm in the Corn Belt (omitted category), (b) Increasing the percentage of land rented (a continuous variable) by one percent reduced the probability of a commercial farm being in category 6 or greater by twelve percent. The left side of the logistic model is a logarithm of the odds of being classified in category j or higher. Since a logarithm is a monotonic transformation, the log odds reveal characteristics of the underlying probability (Pindyck and Rubinfeld). Beta coefficients of dummy variables (region, type, specialization, and business type) act as intercept shifters of the log probability functions of a farm being in category j or greater; negative significant coefficients imply improved financial health and positive coefficients imply the opposite, relative to farms in the omitted class. Coefficients of continuous variables (gross income and percent of land rented) act as slope indicators of the log probability functions; negative significant coefficients imply improved financial health as the independent variable increases; positive coefficients imply the opposite. Magnitude differences of significant coefficients indicate differential intercept shifts and slopes and infer a greater or lesser change in financial health.

In the context of "all farms", farms located in the Northeast, Lake States, Southern Plains, Mountain, and Pacific regions exhibited significantly worse financial health (a higher probability of being in category j or greater) than farms in the Corn Belt during 1984 (α = .01). The financial health of farms

in the remaining regions was not significantly different from that of Corn Belt farms. No region, when considering "all farms", had significantly better farm business financial health than the Corn Belt (i.e., farms in the Corn Belt were not worse off than other regions). In the context of "commercial farms", the Lake States and Southern Plains regions were not significantly different from the Corn Belt region. In 1984, commercial farms in the Pacific region (coefficient .55) likely had a higher probability of being in category j or greater (worse financial health) than farms in the Northeast region (coefficient .39). These results did not support the hypothesis associating poorer financial health with farms in the Corn Belt, Lake States and Northern Plains regions.

On an "all farm" basis, livestock, dairy, and other livestock farms had significantly worse financial health than did grain farms. When minimum size was restricted to $40,000 gross income or more, nursery/greenhouse farms had significantly better financial health than did grain farms. The results support the hypothesis that livestock and dairy farms were likely in worse financial condition. However, in 1984 grain farms were not found to be worse off than other types of farms, except as noted above.

The remaining dummy variables, specialization and business type, were significant with the correct sign, in the context of all farms, but neither was significant when only commercial farms were considered. The significant coefficients (all farms) mean that (a) farms with some but not excessive diversification and (b) those farms organized as proprietorships had better financial health, relative to completely specialized or very diversified farms and those organized as non-proprietorships. The lack of significance on commercial farms is not surprising. Smaller (non-commercial) farms would be

expected to exhibit a greater degree of diversification and a higher incidence of proprietorship organization. Removal of these farms (i.e. commercial farm analysis) results in a more homogeneous sample, relative to these variables, hence the disappearance of significance.

Coefficients for gross income and percent of land rented were significant and had the proper signs. The results support the hypothesis that larger farm businesses and those that rented a greater percentage of land operated were in better financial health. These relationships, characterized by negative coefficients, are illustrated in Figures 1 and 2. Small farm businesses had a very high (low) probability of being in financial health category 6 or greater (1 or less). As farm size increased, the probability of being in financial health category 6 or greater diminished from near 1 to .3; conversely, the probability of being in category 1 or less increased from near 0 to .5. Similar relationships existed for percent of land rented in the contexts of all and commercial farms.

Model validity was substantiated by the likelihood ratio chi-squares of 1474 and 505. The predictive ability of the model is assessed by examining its rank correlation statistic that has a range of 0 (no predictive ability) to 1 (perfect predictive ability). The statistics for this model were .71 and .63, not unreasonable for cross-sectional analysis.

SUMMARY, IMPLICATIONS AND LIMITATIONS

These findings indicate that the "farm crisis" during 1984, when examined from a comprehensive view of business financial health, has potentially more severe implications for farm business financial health in the longer run. Using the same data and addressing the near-term cash crisis, USDA concluded that twelve percent of all farms were financially stressed (USDA, July 1985).

The Federal Reserve, using the same data, suggested that seventeen percent of the commercial farms were financially stressed (Melichar, October 1985). Nearly seventy percent of all U.S. farm business and forty percent of commercial farms were in serious financial difficulty, when off-farm income, inventory changes, depreciation, and unpaid family labor were taken into account. This is not to say that these percentages will fail in the near or not too distant future. Some farm businesses will likely continue to be subsidized by off-farm income and unpaid family labor, and others will survive for some time by delaying the replacement of depreciable assets.

In 1984, financial health was poorest on dairy and livestock farms. Grain farms and farms located in the Corn Belt or Northern Plains regions were not worse off than most others. When restricted to commercial farms, nursery/greenhouse farms were significantly better. Increased farm size and a higher portion of land rented significantly increased the probability of having good financial health. A limited degree of diversification and being organized as a proprietorship were positively associated with financial health only on an "all farm" basis; neither variable was significant on commercial farms.

The results have important implications for agricultural policy. Poor farm business financial health was pervasive in U.S. agriculture during 1984 and was worse in some regions, on some types of farms, and on smaller farms. Tightly targeted economic assistance will only address part of the problem and will result in proliferation of costly specific programs that may reward poor and/or part-time managers that may not warrant, need or desire assistance. A broad spectrum approach designed to shift the distributions in Tables 2 thru 4 upwards will likely have high unacceptable public cost, encourage over-

investment in agriculture, and result in overproduction and low incomes. Policies to assist operators of farm businesses subsidized by off-farm income, unpaid family labor, and/or asset depletion to understand broad economic issues and problems and adjust to economic realities may be useful. Likewise, policies to encourage development, implementation, and participation of farmers in educational and assistance programs that emphasize understanding, attainment, and maintenance of good farm business financial health may be beneficial.

Much of the financial ill health identified in this analysis results from exclusion of off-farm income and inclusion of estimated depreciation. Both are important from a policy perspective. Policies grounded in the concept that the economic well-being of farm businesses includes off-farm income, foster a farm sector dominated by part-time and commercial farms that are subsidized by family members working outside the sector. Farm families themselves, rather than the general public, absorb the hidden costs of ensuring an adequate food supply. On the other hand, policies dependent upon a definition and measurement of farm financial stress that excludes depreciation likely underestimate the severity of the crisis, exacerbate the transition to part-time farms, and jeopardize sector productivity. Despite the lack of observed data, it is quite likely that many farm businesses, during the past five years, have avoided being classified as "financially stressed" by not replacing depreciable assets consumed in production. If current conditions persist, many commercial operators will likely exhaust their ability to "live off depreciation" and find themselves unable to continue in business. Policies designed to address the "farm financial crisis" without considering these components of the problem may be short-

sighted and unable to deal with continued economic deterioration in the farm sector.

The weighted ordinal logistic regression methodology and model used in this study provide a powerful analytical tool for researchers and policy analysts concerned about the financial well-being of the U.S. farm sector. Using the model it was possible to predict, with seventy percent accuracy, the probability of a farm having good, fair or poor financial health, given a distinct set of exogenous variables. However, several limitations likely affect results and model performance. Observed data precluded the inclusion of exogenous variables such as timing, type, quantity and financing of recent capital purchases and operator age, education and management ability--all thought to be important predictors of farm business financial health. Data limitations also necessitated several assumptions and imputations (i.e. depreciation) to obtain a measure of profitability. Hence, a critical dimension of the dependent variable was not expressly observed data. In addition, the dependent variable was created using heuristic criteria and ordering rules. Among other useful issues to be investigated, this study did not, because of data limitations, examine how well the model "correctly" classified the dependent variable conditional on various independent variables.

Further improvement of the data base (i.e. direct observation of components of profitability) and continued development of the model likely will improve model performance and provide fertile ground for future research. The model provides a mechanism for synthesizing global and/or restricted sensitivity analyses with respect to (a) assumptions in the model, (b) satisfactory/unsatisfactory criterion levels for variables used to assess farm

business financial health, (c) alternative formulations for, or observance of, the dependent variable, and (d) the impact of policy variables in an attempt to determine how each would affect the distribution of farms in alternative states of financial health. Continued use of this econometric technique will permit the investigation of a critical policy question--"Is the current farm financial situation a temporary crisis or a new norm?" The answer to this question will play a vital role in determining the development of future policy objectives and programs.

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Table 1. FARM BUSINESS FINANCIAL HEALTH

DEVELOPMENT OF ORDINAL INDICATOR

Measure	Liquidity	Solvency	Profitability	Level of Ordinal Indicator Y_i
Variable	Adjusted Cash Balance	Debt-to-Asset Ratio	Rate of Return to Assets	
Criterion	≥ 0 (+) < 0 (-)	$\leq .5$ (+) $> .5$ (-)	$\geq 4\%$ (+) $< 4\%$ (-)	
	+	+	+	0 (best)
Alternative	+	-	+	1
Combinations	-	+	+	2
of	-	-	+	3
Measures	+	+	-	4
	+	-	-	5
	-	+	-	6
	-	-	-	7 (worst)

+ Satisfactory

- Unsatisfactory

Table 2. FARM BUSINESS FINANCIAL HEALTH

SIZE COMPARISON

U.S. FARMS - JANUARY 1985

Financial Health Category	All Farms	Gross Income At Least $40,000	Gross Income At Least $100,000	Gross Income At Least $250,000
	- - - - - Percent of farms 1/ - - - - - - -			
0 (best)	15	31	35	42
1	4	7	10	13
2	1	3	4	5
3	2	4	5	6
4	10	14	10	6
5	*	*	*	*
6	59	29	25	19
7 (worst)	9	11	11	9

* Less than 1 percent

1/ Percentages may not add to 100 due to rounding.

Table 3.

FARM BUSINESS FINANCIAL HEALTH
REGIONAL COMPARISON
U.S. FARMS - JANUARY 1985

Financial Health Category	All Farms			Commercial Farms 1/		
	Corn Belt	Northeast	N. Plains	Corn Belt	Northeast	N. Plains
	Percent of farms 2/					
0 (best)	20	10	27	33	31	35
1	7	1	6	14	2	8
2	2	*	2	3	*	2
3	3	1	3	6	1	6
4	10	8	11	10	10	13
5	*	*	*	1	*	*
6	49	71	40	23	47	23
7 (worst)	11	8	11	10	8	13

* Less than 1 percent

1/ At least $40,000 gross income

2/ Percentages may not add to 100 due to rounding

Table 4.

FARM BUSINESS FINANCIAL HEALTH
FARM TYPE COMPARISON
U.S. FARMS - JANUARY 1985

Financial Health Category	All Farms			Commercial Farms 1/		
	Grain	Livestock	Nursery	Grain	Livestock	Nursery
	- - - - - Percent of farms[2] - - - - -					
0 (best)	27	8	13	40	24	44
1	7	2	2	9	5	20
2	2	1	*	3	3	*
3	4	1	*	5	5	*
4	11	8	5	11	11	6
5	*	*	*	*	*	*
6	41	72	70	24	40	18
7 (worst)	9	9	11	9	12	12

* Less than 1 percent

[1] At least $40,000 gross income

[2] Percentages may not add to 100 due to rounding.

Table 5. ESTIMATED CHANGES IN LOG PROBABILITIES
FINANCIAL HEALTH CATEGORIES
U.S. FARMS - JANUARY 1985

Variable	All Farms			Commercial Farms		
	Change in Probability of Being in Category ≥6 1/	Beta Coefficient	Chi-Square Statistic	Change in Probability of Being in Category ≥6 1/	Beta Coefficient	Chi-Square Statistic
Region 2/						
Northeast	.08*	.39*	10.8	.10*	.39*	8.8
Lake States	.12*	.57*	36.2	.03	.14	1.8
Northern Plains	.03	.14	2.2	-.02	-.06	.4
Appalachia	.01	.06	.4	-.06	-.24	3.1
Southeast	.03	.15	1.4	.05	.19	1.4
Delta States	.04	.18	2.1	.03	.14	.7
Southern Plains	.06*	.27*	7.9	.04	.17	1.6
Mountain	.14*	.67*	29.2	.11*	.45*	13.1
Pacific	.10*	.49*	13.1	.14*	.55*	10.7
Type of Farm 3/						
Field Crops	.03	.16	2.1	-.02	-.09	.4
Vegetable/Melon	.04	.19	1.0	-.01	-.03	.0
Fruit/Tree Nut	.04	.17	1.0	.04	.14	.3
Nursery/Greenhouse	.04	.18	.9	-.31*	-1.26*	19.7
General Crop	.04	.18	2.1	.06	.26	2.6
General Livestock	.13*	.60*	71.0	.15*	.61*	52.9
Dairy	.16*	.75*	58.9	.16*	.65*	47.5
Poultry/Egg	.02	.11	.3	-.11	-.46	5.9
Other Livestock	.22*	1.05*	25.4	.37*	1.51*	17.7
Ln (Gross Income)	-.11*	-.53*	738.2	-.14	-.57*	162.0
Percent of Land Rented	-.06*	-.29*	16.1	-.12	-.50	32.0
Specialization	-.06*	-.27*	23.7	-.01	-.14	4.9
Business Type	.05*	.25*	9.5	.02	.10	1.3
Model Statistics						
Chi-Square with 22 d.f.		1474			505	
p Value		.0000			.0000	
Rank Correlation Index		.71			.63	

* Significant at = .01
1/ Calculated at sample means for each level of ordinal constant.
2/ Omitted Region : Corn Belt
3/ Omitted Type : Grain